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Proposal 539: Broad-Band $\bar{\nu}$d and $\bar{\nu}$ Nuclei in the 15' BC with ICT

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PROPOSAL (Revised)

TO STUDY ANTINEUTRINO INTERACTIONS IN DEUTERIUM AND NUCLEI WITH AN INTERNAL CONVERTED AND TARGET SYSTEM IN THE FERMILAB 15' BUBBLE CHAMBER

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SUMMARY

We propose a 400,000 photo exposure of the 15' deuterium bubble chamber, with 2-plane EMI and IPF, and with the internal converter and target (ICT) consisting of 4 stainless steel plates proposed by several groups to be placed in the downstream end of the chamber, to a 2-horn broad-band antineutrino beam. Some 12,000 $\bar{\nu}$-deuterium events and a comparable number of $\bar{\nu}$ nucleus events in the plates will be obtained, with π^0 and $e^{\pm}$ detection provided by the plates, and μ identification by the EMI and IPF. This combination will provide new information on strange and charmed particle production, charged and neutral current reactions from neutron and proton targets, and target A dependence of various processes.

17 pgs.

Introduction. Although an impressive array of important physics results is continuing to come out from ν and $\bar{\nu}$ exposures of the 15' BC filled with H_2 and with various Neon-H_2 mixtures, and further interesting physics might be expected from ν and $\bar{\nu}$ exposures to the bare 15' deuterium chamber, there is certain to remain an important domain inaccessible to bare hydrogen and deuterium exposures due to poor neutral particle and $e^{\pm}$ detection and inaccessible to neon exposures because of the complexity of the neon target.

Exposures of the 15' BC, filled with deuterium and provided with the ICT system of stainless steel plates will fill in this gap: the pure d_2 target permits far cleaner separation of $\bar{\nu}n$ and $\bar{\nu}p$ processes, far less contamination due to secondary interactions in the nucleus, and far higher precision on individual track momenta than does neon, while the ICT plates permit far better electron and π^0 identification ($\gtrsim 60\%$ vs. $< 1\%$) than does pure d_2. The combination, pure d_2 target and good π^0 detection, will permit kinematic fitting of complete charged current events including the π^0's and γ's, and complete reconstruction also of neutral current events with only a $\bar{\nu}$ missing. It will thus provide detailed information unavailable from either bare d_2 or neon exposures.

The present proposal is an updated version of our earlier proposal, taking into consideration the particular plate configuration finally chosen for installation.

A deuterium filling has the advantage of giving both $\bar{\nu}p$ and $\bar{\nu}n$ interactions, but the real novelty of the former proposal was the use of plates. Their use adds substantially to the physics obtainable. They represented to us not only a very powerful tool for improving our knowledge of "standard" neutrino physics, but also a means to uncover possible "new" physics. By standard we mean neutral current to charged current total cross sections, differential cross sections $d\sigma/dxdy$ ($x = Q^2/2M\nu$, $y = E_\mu/E_\nu$), and isospin components from neutrons and protons.

These studies are obviously important and their measurement will be greatly improved by the plates. Besides this very important "standard" physics, the plates can help to find new physics in di-lepton and tri-lepton states. The standard interpretation of μe events would have them originate via charmed particles, and in that case, the kinematics would lead to predominately slow electrons. The plates, however, will make it possible to to identify fast μe pairs, if they exist. Their occurrence would suggest "leading particle" effects, and indicate mechanisms other than charm production.

We discuss briefly below some of the examples of important physics studies which the combination of clean neutron and proton targets, good gamma and $e^\pm$ detection, good muon detection, individual hadron measurement, and 12K events will make possible, either for the first time or with considerable improvement over previous studies. Reactions on the plate nuclei will also provide new information on the A dependence of the total $\bar{\nu}$-nucleus cross sections.

Event Rates. We expect about 8.2K $\bar{\nu}$ CC (charged current) events from deuterium (2/3 from protons, 1/3 from neutrons) and 3.3K NC (neutral current) events based on the total number of events found in a $14 m^3$ fiducial volume in E172 (we require $E_\mu > 10$ GeV, $p_\mu > 4$ GeV/c, and muon identified in the EMI). We scale by 0.14/0.74

(density), 1.5 (protons/pulse), 1.6 (2 horns versus horn 2 only), 400K/45K (pictures), 10/14 (fid vol). Assuming the ratio of plate to deuterium mass (and rate) is roughly one, we expect an additional 12K of $\bar{\nu}$ events in the plates. About 15% of the events will have E > 50 GeV. We also expect about 3K each of νD and ν-plate events (or less if we run with the plug. We assume horn 1 will suppress the $\nu/\bar{\nu}$ flux ratio by about a factor 2 over horn 2 only). These events will permit direct comparison of $\bar{\nu}$ with ν CC reactions in our experiment alone. Comparison with NC results of the corresponding $\bar{\nu}$D experiments should permit us to correct for ν NC background in the $\bar{\nu}$ distributions.

We expect also about 100 $\bar{\nu}_e$ and a comparable number of ν_e events (based on E172 results). The combination of good kinematics and neutrals detection will make these events far more valuable than the ν_e and $\bar{\nu}_e$ events produced in neon, for extending the domain of energy and Q^2 over which μ-e universality has been tested.

PHYSICS INTEREST

1) Charm and Strangeness Production. This experiment will shed new light on the dynamics and quantum number structure of strangeness and charm production in $\bar{\nu}$D and $\bar{\nu}$N interactions. In E172 the fractions of μ^+e^- and μ^-e^+ production relative to $\bar{\nu}_\mu$ and ν_μ charged current interactions in a broad-band beam containing both ν and $\bar{\nu}$ were reported[1] to be $f = (0.15 {+0.14 \atop -0.08})\%$ and $f = (0.34 {+0.23 \atop -0.13})\%$ respectively, with $f'/f = 0.45 {+0.6 \atop -0.3}$.

We expect that 1-2% of our 12K events will involve charmed particle production and from GGM results (and $\sin^2\theta_c = 0.05$), about 5% should involve single strange particle production. It is clear that to sort out the various states involved, the various quantum number structures ($\Delta S = -\Delta Q$, I-spin structure, etc.) and to test various models for the dynamics (production off sea vs. valence, etc.), it will be essential to have free-nucleon kinematics, separable N and P targets, and complete reconstruction of individual events including their π^o's. Even a few fits of complete events to such reactions as $\bar{\nu}D \rightarrow \mu^+e^-$ (ν_e) $K^o\Lambda^oP$ would do much to settle current controversies over how many strange particles are produced per di-lepton event and to confirm that production off the strange sea dominates charm production by $\bar{\nu}$'s. Note that 2 of E172's 4 $\bar{\nu} \rightarrow \mu^+e^-X$ events have a lambda among the outgoing particles forming X but in neon it is impossible to confirm that a $\nu + K^o$ is missing. Note also that in most cases X will include π^o's, so that good gamma detection is essential for kinematic fitting. The reaction $\bar{\nu}\ \bar{s} \rightarrow \mu^+ + \bar{c}$ would leave a spectator sea s quark which would be quite likely to dress up into a lambda.

We would hope that the second EMI plane coverage and the IPF will have been improved over E180 and E172. We should therefore have fully-reconstructed $\bar{\nu}$-produced dimuon events to compare with our μe events and with ν-produced dimuon events from other experiments. Our events will be much less affected by secondary interactions in the target nucleus and detector, close showers, etc., and much less affected by $\bar{\nu}$-ν confusion problems. Comparison of μe and $\mu\mu$ events in the same experiment, produced in precisely the same flux, will be of great interest, for example, in resolving the apparent discrepancy between the various bubble chamber μe and various counter experiments $\mu\mu$ (corrected for acceptance) rates.

Examples of charm production reactions where gamma and π^o detection is crucial include:

$$\bar{\nu}p\ (\text{sea}\ \bar{s}) \rightarrow \mu^+\bar{D}^o n \quad (\bar{D}^o \rightarrow K^o\pi^o)$$

$$\rightarrow \mu^+D^-p \quad (D^- \rightarrow K^o\pi^-)$$

$$\bar{\nu}n \rightarrow \mu^+D^-n$$

$$F^- \rightarrow \eta^o\pi^-$$

$$\bar{F}^* \rightarrow \bar{F}\gamma$$

If the charmed particle leptonic branching ratios are indeed of order 10%, we would expect a few hundred total charmed particle decays.

Note that without good kinematics and gamma detection it is impossible to separate single from associated strangeness (and charm) production. They will be necessary a fortiori to have any hope of measuring $\Delta S = -\Delta Q$ (charm decay?) contributions and of detecting conceivable $\Delta S = 2$ transitions (e.g., $\nu p \rightarrow \mu\ \Xi^o$, $\Xi^o \rightarrow \Lambda\pi^o$, etc.).

We will continue to be alert to the possibility that some of the dilepton events may be produced by the decay of heavy leptons, beautiful particles, etc.

Some reactions where gamma and π^o detection are essential are

$$\bar{\nu}N \rightarrow \mu^+\omega^o x$$

$$\rightarrow \mu^+\rho^o x$$

$$\rightarrow \mu^+\eta^o x,$$

as well as the corresponding NC reactions which are of great interest with respect to the V, A structure of the NC interactions.

It is, of course, of great interest to determine the structure functions separately for P and N targets for both CC and NC interactions, both for ν and $\bar{\nu}$ interactions.

Aside from the general determination of the structure functions, there are several aspects of the space-time structure of the weak interactions which are of intense current interest. For example, Bjorken (ν77) has pointed out that if σ_L/σ_T in electroproduction is as large as 0.2, then significant terms linear in (1-y) should appear in the $\bar{\nu}$ y distributions. To exhibit such subtle effects convincingly (and in passing shed further light on what anomalies may be present in the y distributions) will obviously require precise data unsmeared by nuclear and liquid secondary interactions, missing π^0's, and poor muon identification. Even in the absence of y anomalies, it is quite clear that the events produced at high y and high energy (perhaps low x as well) are among the most promising candidates for effects of new flavors and of the sea in general to show up.

2) <u>$\sigma(n)$, $\sigma(p)$. CC and NC Interactions</u>. Assuming that the proton is composed primarily of 2 up and one down quark, (p = uud) and n = udd, with identical sea components in p and n; also that the basic CC interaction is $\bar{\nu} + u \rightarrow \mu^+ + d$ (i.e., the d valence quarks don't contribute to $\bar{\nu}$ interactions), then $\sigma(p) - \sigma(n)$ should have only a valence (u) quark contribution (and no sea contribution) while $2\sigma(n) - \sigma(p)$ should have only a sea (and no valence) contribution. It will surely be of great interest to separate valence and sea contributions to a wide variety of reactions and processes, beyond those accessible to bare DBC experiments, using the plates for π^0 detection (and far beyond the possibility of separating $\sigma(n)$ and $\sigma(p)$ clearly in neon).

3) Events in the plates are not without interest. In spite of secondary interactions in the nucleus and on the way out of the plates, and in spite of γ showers in the plates, the total CC event rates can be determined as a function of target mass number A, of neutrino energy and of lepton to hadron momentum transfer. That the deuterium and the plates are exposed to precisely the same $\bar{\nu}$ (and ν) spectrum and flux in the same experiment (and to the same analysis) is essential to an accurate estimate of $\sigma(A)/\sigma(d)$. If $\sigma(A)$ is not precisely proportional to A then a very important line of research opens up (finite mass of W?, interference effects as in photoproduction?, coherent effects?, effects of nucleus on sea quarks?, etc.)

Although it would be desirable to have plates of different thicknesses (as in our original proposal), by studying the dependence of various observables on the interaction position, it should be possible to determine the effect of secondary interactions on the way out from the effects of secondary interactions in the target nucleus. It will be of considerable interest to compare neutrino and hadron interactions as to the charged (and neutral) multiplicity dependence on A. Any difference between the propagation thru nuclear matter of hadronic vs. photo or electroproduced vs. neutrino induced showers would, of course, be of great interest. For example, some Charmed and ψ particles and particles carrying new quantum numbers (beauty?) should have lifetimes long enough usually to decay outside the target nucleus and should have lower interaction cross sections than ordinary states.

A considerable fraction (probably over half) of the plate events will be clean enough to measure and analyse as we currently analyse neon events; thus they should contribute to the high y anomaly and other studies done on the deuterium events.

4. <u>New Particle Searches</u>. Aside from the charmed and beautiful particle searches alluded to above, we will keep an eye out, of course, for heavy leptons (those with the same lepton number as μ or e should decay to same via a γ converting in the plates, those with new lepton numbers should decay to μ or e with a $\bar{\nu}_{\mu \text{ or } e}$ and a ν_{new} - i.e., 2 neutrinos - thus free nucleon kinematics will be important), intermediate bosons, monopoles, etc.

<u>Analysis</u>. The Berkeley group is currently involved with nearly 100% of our effort in measuring and analysing events from the E172 $\bar{\nu}$-heavy mix experiment (in collaboration with LBL, Hawaii and U. of Washington groups) and E546 with LBL, Fermilab, U. of Washington, Hawaii, and Wisconsin. We have now considerable experience in the analysis of 15' BC events in a variety of liquids, and using the EMI.

The above experiments would enjoy comparable priority with this proposed experiment, but their measurements, we expect, should be finished ahead this one's run. Berkeley has one approved (E89) and one proposed hadron Fermilab experiment and one approved ANL experiment which we would consider to be of lower priority than this one, if they should conflict.

Originally proposal 539 was made by the Berkeley group alone. The current revised proposal associates the group at UC Davis with the Berkeley group to make possible more rapid reduction of the data and increase of the requested number of photographs to take. We regard this as an important experiment that should be done rapidly and with as high statistics as possible. For this reason we would welcome other groups interested in νd physics as collaborators, particularly if a larger number of photographs could then be provided.

Plate Arrangement, Efficiencies, etc. In the course of the discussions leading to the adoption of a compromise plate configuration, numerous calculations were presented to the PAC regarding efficiencies. For this reason we have not repeated this information in this proposal.

Reference

1. H. C. Ballagh, Physical Review Letters (in press). (E172)

Proposal 539: Broad Band νd and ν Nuclei in the 15' BC with ITC

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PROPOSAL

TO STUDY ANTINEUTRINO INTERACTIONS IN DEUTERIUM AND NUCLEI WITH AN INTERNAL TARGET AND CONVERTER SYSTEM IN THE FERMILAB 15' BUBBLE CHAMBER

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SUMMARY

We propose a 300,000 photo exposure of the 15' deuterium bubble chamber, with EMI and with the internal target and converter (ITC) system proposed for P489 (νH_2 + plates) and P521 (νD_2 + plates), using a (2-horn or improved) broad band antineutrino beam. Some 13,000 $\bar{\nu}$-deuterium and a comparable number of $\bar{\nu}$-nucleus events will be obtained with π^0 and e^+ detection provided by the plates. New information should be obtained on: dilepton events; possible high y anomalies; on comparison of various reactions from neutron and proton targets (thus separation of valence quark from sea quark processes); on strange particle production; on the target A dependence of various processes. New particles and processes will be reached for.

Introduction. Although an impressive array of important physics results is continuing to come out from ν and $\bar{\nu}$ exposures of the 15' BC filled with H_2 and with various Neon-H_2 mixtures, and further interesting physics is expected from the coming ν-and $\bar{\nu}$-d exposures, there is certain to remain an important domain inaccessible to bare hydrogen and deuterium exposures due to poor neutral particle and $e^{\pm}$ detection and inaccessible to neon exposures because of the complexity of the neon target, secondary interactions within it, and its being limited to a single Z.

Exposures of the 15' BC, filled with deuterium and provided with the internal target and converter (ITC) system will fill in this gap: the pure d_2 target permits far cleaner separation of $\bar{\nu}n$ and $\bar{\nu}p$ processes, far less contamination due to secondary interactions in the nucleus, and far higher precision on individual track momenta than does neon, while the ITC plates (e.g., 9 plates of 0.9 cm steel, 0.5 radiation length and 0.07 nuclear interaction length each, 30 cm apart - see P489 proposal; or, as we propose, 3 plates each, of varying thickness, of 3 materials, e.g., aluminum, stainless, tungsten) permit far greater electron and π^0 identification ($\gtrsim$ 80% vs < 1%) than does pure d_2. The combination, pure d_2 target and good π^0 detection, will permit kinematic fitting of complete charged current events including the π^0's and γ's (and complete reconstruction also even of neutral current events with only a $\bar{\nu}$ missing). It will thus provide detailed information unavailable from either bare d_2 or neon exposures.

The reactions on the plate nuclei will permit study of the A dependence of certain processes.

Event Rates. We expect some 9K $\bar{\nu}$ CC (charged current) events from deuterium (2/3 from protons, 1/3 from neutrons) and 3.6K $\bar{\nu}$ NC (neutral current) events, based on E172's total number of in-fiducial-volume $\bar{\nu} \to \mu^+$CC events (~3.8K) and scaling by 0.14/0.75/density), 1.3 x 10^{13}/1.0 x 10^{13}ppp, 1.6 (2-horns vs horn 2 only), 300 Kpix/48 Kpix. Assuming the ratio of plate to deuterium mass (and rate) is 1.3 for an appropriate fiducial volume, we expect an additional 16K $\bar{\nu}$ events from the plates (split among the two or three different plate materials we propose). The current EMI would intercept ~80% of all μ^+ and most of the μ^+ from events above ~50 GeV (~15% of the events will have E $\gtrsim$ 50 GeV, if no plug is used). There will be in addition a "background" of ~5K ν-d and 6.4K ν-plate events if we run (as we propose to) without the plug for the bulk of the exposure at least, in order not to suppress the high energy $\bar{\nu}$ interactions, and in order to study directly $\bar{\nu}/\nu$ ratios for various interesting processes (e.g., $(\mu^+e^-/\mu^+)/(\mu^-e^+/\mu^-)$).

PHYSICS INTEREST

1) Dilepton events. Because the relative rate $(\bar{\nu} \to \mu^+e^-/\bar{\nu} \to \mu^+)/(\nu \to \mu^-e^+/\bar{\nu} \to \mu^-)$ is only $\approx 0.2 {+0.3 \atop -0.2}$ (E172 preliminary result) and because $\bar{\nu}$ fluxes and cross sections are so low, it is highly unlikely that more than a half dozen or so $\bar{\nu} \to \mu^+e^-$ events will have been added by E180 and E460 to E172's small sample over the next year or so. Thus even a few fully reconstructed events using the advantages of nearly free nucleon target kinematics, higher track measurement precision (especially on the e^-), π^0 reconstruction (via the plates) and better sidewise muon identification, will very likely add crucially important clues to the nature of these mysterious events. Assuming the E172 preliminary rate for $(\bar{\nu} \to \mu^+e^-)/(\nu \to \mu^+)$ of 0.1%, we expect only 9 μ^+e^- events but ours may be the key ones. Note that without good π^0 detection, it is impossible to tell whether

or not a $\bar{\nu}$ is missing, as expected (cf P521), and it is clearly impossible to do so with a neon target.

The relative rate of $\bar{\nu} \to \mu^+ e^-$ and $\nu \to \mu^- e^+$ is, in the quark model, a measure of the presence of $s\bar{s}$ strange quark-antiquark pairs in the sea. In this picture $\bar{\nu} \to \mu^+ e^-$ goes only via $\bar{\nu} + \bar{s} \to \mu^+ + \bar{c}$ ($\bar{c}$ = charmed antiquark) with amplitude proportional to $\cos\theta_{\text{Cabibbo}}$ while $\nu \to \mu^- e^+$ can go both via $\nu + s \to \mu^- + c$ (with $\cos\theta_c$ from the sea) and via $\nu + d \to \mu^- + c$ (with $\sin\theta_c$ from valence down quarks). Because $\cot^2\theta_c \approx 20$, the sea and valence contributions to $\nu \to \mu^- e^+$ could be of the same order, and the relative rate ratio $(\bar{\nu} \to \mu^+ e^- / \bar{\nu} \to \mu^+)/(\nu \to \mu^- e^+ / \nu \to \mu^-) = R$ need not be small. E172's preliminary result, $R \sim 0.2 {}^{+.3}_{-.2}$ suggests that the sea contribution is less than the valence, but clearly more data is needed to measure this.

We would hope that the 2nd EMI plane coverage and perhaps timing information will have been much improved over E460 (and E180). We should also, therefore, have fully reconstructed dimuon events to add, unsmeared by secondary interactions in neon, close showers, etc.

2) <u>$\sigma(n)$, $\sigma(p)$</u>. <u>Valence and Sea Quark Contributions</u>

Assuming that the proton is composed primarily of 2 up and one down quark, (p = uud) and n = udd, with identical sea components in p and n; also that the basic CC interactions is $\bar{\nu} + u \to \mu^+ + d$ (i.e., the d valence quarks don't contribute to $\bar{\nu}$ interactions), then $\sigma(p) - \sigma(n)$ should have only a valence (u) quark contribution (and no sea contribution) while $2\sigma(n) - \sigma(p)$ should have only a sea (and no valence) contribution. It will surely be of great interest to separate valence and sea contributions to a wide variety of reactions and processes, beyond those accessible to bare DBC experiments, using the plates for π^0 detection (and far beyond the possibility of separating $\sigma(n)$ and $\sigma(p)$ clearly in neon). Note $\bar{\nu}p(\text{sea } \bar{s}) \to \mu^+\bar{D}^o n$, $\to \mu^+ D^- p$, $\bar{\nu}n \to \mu^+ D^- n$, ($\bar{D}^o \to \bar{K}^o\pi^o$, $\bar{D}^- \to K^-\pi^o$) for example, $F^- \to \eta^o\pi^-(?)$, $\bar{F}^* \to \bar{F}\gamma(?)$, also $\bar{\nu}n \to \mu^+\omega^o X$, $\mu^+\rho^\pm X$, $\mu^+\eta^o X$, etc., as examples of reactions where the γ and π^o detection is crucial.

3) High y Anomaly. Although E172 (and future E180 and E460 runs) will verly likely shed considerable further light on the existence of a high y anomaly and on its nature, it is very likely that completely reconstructed events, including π^o's, unsmeared by secondary interactions in neon, and with the far better mass and missing mass resolution possible in deuterium than in neon, also the improved sidewise (high y) muon detection afforded by the plates, will be necessary to convincingly exhibit and explain the high y anomaly. Of course if the anomaly is due to a new quark ("beauty", $\bar{\nu} + u \to \mu^+ + b$, etc.), π^o detection and good kinematics is very likely to be necessary to help prove it.

4) Strange particle production. Aside from the interest of strange particles accompanying charmed particle production, the old fashioned strange particle production viewed as $\bar{\nu} + u \to \mu^+ + s$ remains of considerable interest. Here again, good kinematics and γ (cf $\Sigma^o \to \Lambda\gamma$) and π^o (cf $Y^* \to \Lambda\Pi^o$, $\Sigma\Pi^o$, etc.) detection appear essential. Without good Π^o detection and good production kinematics also, it would seem impossible to separate clearly single strange particle production from associated production at the hadron vertex. Any sign of $\Delta s = 2$ transitions (cf $\bar{\nu}p \to \mu^+ \Xi^o$, $\Xi^o \to \Lambda\Pi^o$) would, of course, be very exciting.

5) Events in the plates are not without interest. In spite of secondary interactions in the nucleus and on the way out of the plates, and in spite of γ showers in the plates, the total CC event rates can be determined as a function of target mass number A, of neutrino energy and of lepton to hadron momentum

transfer. That the deuterium and the various plate A's are exposed to precisely the same $\bar{\nu}$ (and ν) spectrum and flux in the same experiment (and analysis) is, of course, essential to an accurate estimate of $\sigma(A)/\sigma(d)$. If $\sigma(A)$ is not precisely proportional to A then a very important line of research opens up (Finite mass of W?, Interference effects as in photoproduction?, Coherent effects?, Effects of nucleus on sea quarks?, etc.)

By putting plates of different thickness (same A) as well as different A's, and by choosing events near the outgoing face of each plate, it should be possible to extrapolate out the effect of secondary interactions on the way out from the effects of secondary interactions in the target nucleus. It will be of considerable interest to compare neutrino and hadron interactions as to the charged (and neutral) multiplicity dependence on A. Any difference between the propagation thru nuclear matter of hadronic vs photo or electroproduced vs neutrino induced showers would, of course, be of great interest. For example, some Charmed and ψ particles and particles carrying new quantum numbers (beauty?) should have lifetimes long enough usually to decay outside the target nucleus and should have lower interaction cross sections than ordinary states.

A considerable fraction (probably over half) of the plate events will be clean enough to measure and analyse as we currently analyse neon events; thus they should contribute to the high y anomaly and other studies done on the deuterium events.

6) <u>New Particle Searches</u>. Aside from the charmed and beautiful particle searches alluded to above, we will keep an eye out, of course, for heavy leptons (those with the same lepton number as μ or e should decay to same via a γ converting in the plates, those with new lepton numbers should decay to μ or e with

a $\bar{\nu}_{\mu \text{ or } e}$ and a ν_{new} - i.e., 2 neutrinos - thus free nucleon kinematics will be important), intermediate bosons, monopoles, etc.

Analysis. We are currently involved with nearly 100% of our effort, in measuring and analysing events from the E172 $\bar{\nu}$-heavy mix experiment (in collaboration with LBL, Hawaii and U. of Washington groups). We have now considerable experience in the analysis of 15' BC events in a variety of liquids, and using the EMI, and we are currently striving to increase our measuring power. We hope to participate in further analysis of E460 events as well and in E388 (dichromatic-$\bar{\nu}$-neon) when it runs. The above experiments would enjoy comparable priority with this proposed experiment, but their measurements, we expect, should be finished well ahead this one's run. We have one approved (E89) and one proposed hadron Fermilab experiment and one approved ANL experiment which we would consider to be of lower priority than this one, if they should conflict. We hope to enjoy enough support that measuring power will not limit the physics output of these experiments.